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# Investigating Cancer Clusters Brooks AFB TX

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Final Report



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This manual provides several important types of information for investigating cancer clusters. First, it provides background on carcinogenic hazards and their relation to the environment. Second, it provides techniques for ascertaining cases, defining the population at risk, and for narrowing the scope of an investigation. Lastly, it provides a step by step protocol for conducting a cancer cluster investigation.

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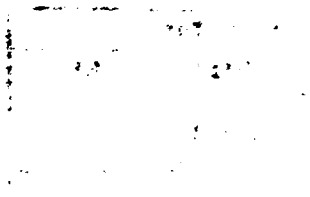

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## I. INTRODUCTION

A. This guide has been written to provide a protocol for investigating cancer clusters in the Air Force.

B. A driving force behind many requests for cancer cluster studies is the public perception that the number of cancers occurring in a locality is unusual, either in number or type. Reaction from workers, citizens, and commanders; fueled by the media, may create an emotionally charged atmosphere with the perceived cancer cluster as its cornerstone (Schulte, et al., 1987). Pressure may be placed on medical personnel to conduct studies which will prove or refute the allegations. Such "knee jerk" epidemiology may consume precious time and resources, without reaching any substantive conclusions. Unfortunately, the demand for cancer cluster investigations is likely to increase in the future as our society is increasingly health conscious, environmentally aware, and likely to focus on cancer as an endpoint for environmental contamination (Rothman, 1987).

C. This manual provides several important types of information. First, it provides background on carcinogenic hazards and their relation to the environment. Second, it provides techniques for ascertaining cases, defining the population at risk, and narrowing the scope of the investigation. Lastly, a step by step protocol for conducting a cancer cluster investigation is presented.

## II. BACKGROUND

A. Discussions held at a recent conference on clustering of health events at the Centers for Disease Control suggested that with few exceptions there is little scientific or public health reason to investigate individual cancer clusters (Anon., 1989, and Rothman, 1989). Yet, cancer clusters receive prompt attention by many state public health departments, who view them as important avenues for health education. In many cases, these investigations are exercises in public relations, leading one prominent investigator to call them "therapy for an 'injured' cohort" (Raymond, 1989).

B. The cost and unreliability of cluster studies might argue for them to not be performed, particularly as lay reports of clusters yield many false alarms (Rothman, 1990). However, beyond the immediate need to address public concerns, scientific reasons for pursuing cancer cluster investigations could be to:

1. Detect previously unknown hazards by noting unusual patterns of disease.

2. Lead to re-evaluation of previously established exposure limits.

3. Generate questions for experimental research.

4. Provide a study setting unobtainable in the laboratory.

5. Sound the alarm for a general, environmental problem, as workers often serve as an intensely exposed sentinel population (Decouflé, 1982).

C. Technically, to be considered a cancer cluster, an excess of cancers must statistically exceed the amount of cancer expected in a demographically similar population (Jagger, 1985). More commonly a cluster may be detected due to a public perception that an excess either in number or of a rare type of cancer is occurring in a limited population. These reports are difficult to interpret, since even if the disease is occurring at random, some clustering is bound to arise by chance alone (Smith, 1982). Putting it another way, clusters will occur continually within any large population, but their population-wide occurrence may be no greater than that expected to appear serendipitously (Garfinkel, 1987). The difficulty is in explaining the concept of "chance" to an anxious population (Schulte, et al., 1987).

D. There is little mystery to the study of cancer clusters. Generally, cluster investigations are limited to the examination of either the temporal or spatial relationships between cases, although other relationships can be examined. When space and time are considered together, the investigation can become quite powerful as causes may be restricted to a more limited set of hazards. The problem with such methods is the number of different time and space combinations which must be examined statistically with different results (Garfinkel, 1987).

E. The objective of most investigations of apparent clusters has been to determine whether there actually was an excess of cases, if the cases were occurring independently or if they were related, and if any environmental factors are part of the causal pathway (Schulte, et al., 1987). Commonly, there are several problems encountered when contemplating a cluster study. The major issue might well be the small number of cases that are generally encountered. Another common problem is incomplete personnel records, which leads to a difficult issue, an inability to define the population at risk, and an inability to define the spatial and temporal limits of the cluster (Warner, et al., 1988). Complicating the picture are the complexity of the variables involved, and the controversial nature of the statistical methods that are employed (Smith, 1982). Finally, the biologic plausibility of the alleged cluster may be called into question.

F. The problems inherent in performing cluster studies have been illustrated in several recent reviews of cluster investigation series. Among 108 cluster investigations performed by the Centers for Disease Control from 1961 to 1989, none clearly defined a space-time cluster (Caldwell, 1990). Using a

staged approach, the Wisconsin State Public Health Department investigated 109 potential cancer clusters from 1979 to 1989. None required in-depth investigation (Fiore, et al., 1990). Similar results were found in Missouri, with 101 cancer clusters and three investigations (Devier, et al., 1990) and in Minnesota, with 400 reports and approximately four detailed investigations (Bender, et al., 1990).

G. The difficulties encountered in performing these studies, and the low yield of clear results, indicates a need for a step-wise approach which will allow the investigator to conclude the study at any stage allowing the most efficient use of time and resources. The protocol presented here will help to eliminate some of these problems, and give a method for investigating cancer clusters with a response appropriate to the needs of the population under study, the political climate, and the desire for scientific investigation.

## III. PROCEDURES.

**A. General principles.** There is no single protocol which contains all of the steps necessary to conduct a cancer cluster investigation. The procedures presented here have been adapted from the protocols of several different state public health departments (Fiore, et. al., 1989, Devier, et. al., 1989, and Bender, et. al., 1989). Changes and additions have been made to fit the needs of Air Force investigators. The following general steps should be followed (Bender, et. al., 1988):

1. Establish communication with the concerned parties.

2. Rapidly analyze and interpret any data collected by the concerned party.

3. Perform additional data collection and analysis, if needed.

4. Accomplish a feasibility study before further action.

5. Complete a detailed epidemiologic and environmental analysis.

**B. Establish communication with the concerned parties.** A rapid, sympathetic response can place medical authorities in an early leadership position. Exploring the facts and interpreting the concerned party's observations may do much to alleviate public fears and contain what may essentially be a perceptual problem. As the investigation continues, there should be opportunities to perform health education. Several common misconceptions that may be corrected during the course of an investigation are:

1. The belief that the rarer the cancer, the more likely it was to be caused by an environmental hazard (Jagger, 1985). Simply because an event is rare, and literature citing environmental causes of cancer is rare, does not imply that the two are linked.

2. The public may not be aware of how cancers are distributed among a population, regardless of exposure to any hazards (Schulte, et al., 1987). The truth is that the percentage of cancer in any location generally parallels that found in any other segment of society. Further, workers are often unaware that young people can develop cancer, albeit not as frequently as older people (Schulte, et al., 1987). This may be a good time to discuss the distribution of the cancer in the general population, for comparison. Cancer rates in the general population are shown in Appendix A.

3. Above all, begin discussion of the biologic association between the cancer and any potential hazards as early in the investigation as possible. For instance, there may be no exposures to known carcinogens in the environment. Further, only 23 chemicals and seven work processes have been definitely linked by the International Agency for Research in Cancer (IARC) with human cancers and only another 61 are probably linked. These are shown in Appendix B.

a. The latency between exposure and diagnosis of cancer may not agree with the scientific literature (Decouflé, 1982). The problem of latency may be influenced if the work force is young, as they will not have reached the peak years of normal cancer incidence. As a general rule of thumb, the minimum latency for noncutaneous cancers is usually at least five years, with a large number occurring from 10 to 30 years after exposure (Decouflé, 1982).

b. Qualitative evaluation of dose-response relationships may be useful. If administrative workers develop cancer, and no technical workers who are exposed to carcinogens develop cancer, then a "qualitative" dose-response relationship has not been established.

c. Several occupational cancers are associated with particular pathologies, such as acute myeloid leukemia and benzene exposure (Decouflé, 1982). See Appendix C for more details. If the cluster includes cancers of many different sites, it is almost certainly not a true cluster. Environmental carcinogens are usually associated with only one or two anatomic sites. The most common cancers associated with carcinogens involve the lung and bladder (Decouflé, 1982). Interactions between the agent and nonoccupational factors or other hazards present in the environment may make interpretation of exposure data difficult.

4. Lastly lay the groundwork for further investigation by introducing the steps needed to demonstrate causality. A good discussion of causality can be found in any epidemiology text.

5. Public education and public relations are the main tasks at this stage (Raymond, 1989). Rapid biologic and epidemiologic interpretation and explanation of the existing facts may allow for the conclusion of the investigation at this point.

**C. Analyze and interpret readily available data.** In most cases the concerned parties will have collected some data. Collection of a complete data set is the first step in performing the investigation. Frequently, the information shown in Table 1 can be obtained during the first contact between the concerned party and the investigator (Fiore, et al., 1990).

**Table 1. Data to Collect When Initiating an Investigation.**

- Type(s) of cancer
- Number of cases
- Vital status of cases (alive or deceased)
- Age
  - -- At first exposure
  - -- At onset
  - -- Current age or age at death
- Race
- Sex
- Location
  - -- Of the apparent cluster
  - -- Residences
- Time period
- Population at risk
- Suspected cause

1. **Describe the Cluster.** The classical description of time, place and person applies here. In addition, knowledge of the types of cancer, latency, length of exposure, and suspected carcinogen is important.

2. **Determine a preliminary rate.** If the rate in the population under study is much less than the national average, the study might be concluded at this point. A simple calculation of the cancer rate per thousand population should be enlightening. Age adjusted estimates for different cancers, by sex, are included in Appendix A to help determine expected rates. The concerned parties may be satisfied if they learn that the cancer rate in their population, although it may seem high, is actually less than expected. The conclusions drawn from this early assessment should be tempered by possible ecologic fallicies, and by an inability to accurately determine the

denominator for the study population. If the calculated rate exceeds the expected, then further study might be warranted. Always remember though, cancer clusters are inherently nonrandom, therefore, statistical significance, or a lack of it, may have little meaning.

D. **Perform additional data collection.** Several key actions must be performed at this step.

1. **Verification of existing diagnoses.** Review of the medical records of all known cases is important. The gold standard for case verification should be a histopathologic diagnosis, if available.

2. **Complete case ascertainment.** Given the heavy weighting that a small number of cases may present, every case of cancer in the exposed population must be discovered. Several methods are available. Medical records can be reviewed, but records may not be readily available for civilian employees. A comparison could be made between personnel tapes and a local cancer registry, attempting to match on social security numbers. Death certificates for the surrounding area could likewise be examined. A questionnaire distributed to the employees may reveal the most cases, and be the easiest method to perform. Employees can be asked if they have had a cancer, or know of any other employee, whether currently employed or not, who has had cancer. If follow-up on all leads is performed, rapid, complete ascertainment should be possible.

3. **Definition of the population at risk.** Establishing the number of individuals exposed to a hazard is central to calculating accurate rates. This task may be easier said than done, considering the state of many personnel records. When a small population is involved, interviewing a supervisor may yield the required information, such as total personnel by sex, age and race. If the population is large, or rapid turnover of supervisors has occurred, then definition of the population at risk becomes a thornier problem. Although it may be "cheating" statistically, describing the characteristics of the current population in the shop may be the best you can do. Appendix D contains a DESIRE which can be used by the Personnel Systems Management Section at CBPO. Running this DESIRE will yield a printout of the total population of every shop on your base, broken down by age and sex and age and race.

4. **Determine the cancer rate in a comparison population.** The rate of cancer in a population with similar characteristics, but hopefully not exposed to the same hazard, will be needed to determine the expected rate of cancer in the study population. Local or state tumor registries may be a good source of information. Try to get data for the same county in which the study population is located. Good references are the Bureau of the Census Statistical Abstract of the United States, and the National Cancer Institute Surveillance, Epidemiology and End Results (SEER) reports. Possibly the best source of

information is "US Cancer Mortality Rates and Trends, 1950 - 1979," published by the National Cancer Institute and the Environmental Protection Agency. If you are unable to obtain these references locally, call the AFOEHL, and we will get the data for you. Don't worry that a case in the study population may be counted in the comparison population. Usually the study population will be such a small fraction of the comparison group that the effect of including cases in the comparison group will be nonexistent. In some instances, local comparison data will not be available in which case it is acceptable to use the population of a state or the entire country. These data can be found in annual issues of CA-A Cancer Journal for Clinicians.

5. **Assess the risk of the exposed population.**

a. Perhaps the easiest way to examine the data is to build a fourfold table and then calculate the relative risk. The relative risk calculation will estimate the likelihood of death or disease in the exposed versus the unexposed. Thus it will yield a measure of the excess rate of disease among the exposed. If the study and comparison populations differ significantly in terms of demographic and special interest factors, then standardization should be performed to eliminate the effect of confounding factors. In this instance, a standardized rate ratio would be calculated.

b. In some circumstances, it may be impossible to determine the population at risk. The use of a proportional mortality or morbidity rate (PMR) calculation may provide the best results. In this instance, a denominator isn't required, only the mortality rate in the study population is needed. Interpretation of PMRs may be difficult, so try to reserve this calculation for those situations where denominator data is not readily available.

c. Perhaps the strongest estimate of the mortality associated with a given cause is the standardized mortality rate (SMR). Use of SMRs will correct for the two most common sources of confounding, age and sex. Care should be used when interpreting the results. Concluding that any observed difference results from a given cause requires that all other causes be eliminated first.

d. Use statistical tests with caution. The data must be as accurate as possible. The results must be examined closely. Over reliance on statistical "proof" without consideration of the biologic plausibility of the association may lead to a wild goose chase. Remember, "statistically significant" does not necessarily mean "causally associated".

E. **Examine potential exposures.** Use either existing environmental data, or collect new data. Determine if the existing exposure is significant based upon whether or not it exceeds state or federal health standards. If no specific causal

agent has been identified, then environmental testing should not be performed at this time (Fiore, et al., 1990).

F. **Assess biologic plausibility.**

1. Conduct a literature review for existing clusters occurring under similar circumstances.

2. Consult with available physicians, toxicologists, and epidemiologists.

3. Consider the biology of the situation.

a. Are all of the cancer cases similar? If many different types of cancer are present, then the likelihood of a single cause is lessened.

b. Is there sufficient latency between exposure and diagnosis?

c. Is the suspected exposure recognized as causing the cancers that are present? The information presented in Appendixes B and C should be helpful in this regard.

G. **Accomplish a feasibility study before further action.** The main factors to consider before continuing are:

1. The rate of cancer in the study population. The number of cases should exceed the number expected by at least a factor of two.

2. The availability of documented exposures. A specific study group must be definable. A time frame for exposure must be identified.

3. The biologic plausibility of the proposed study hypothesis.

These factors translate into a nomogram, which can be used to determine if further actions are necessary, as shown in Table 2.

4. Consideration should also be given to evaluating available environmental and toxicological data (Bender, et al., 1988).

5. Having decided that there is sufficient cause to conduct an investigation, several epidemiologic/study design factors should be considered before proceeding (Bender, et al., 1990)

a. Can individual exposure measurements be obtained?

b. Can potentially confounding factors be identified and controlled in the study?

**Table 2. Feasibility Study Nomogram for Cancer Cluster Studies[a]**

| High Disease Rate | Documented Exposure | Biologic Plausibility | Further Action |
|---|---|---|---|
| Y | Y | Y | Y |
| Y | N | Y | Y |
| N | Y | Y | Y |
| Y | Y | N | Y |
| N | N | N | N |
| Y | N | N | N |
| N | Y | N | N |

[a]Adapted from Fiore, et al., 1990. 'Y criterion met; 'N', criterion not met.

c. Are there new cases which can serve as study subjects?

d. Can the population at risk be adequately defined?

e. Will adequate statistical power be available to detect significance (will there be enough cases)?

f. Will a measurable biological endpoint be available?

6. If all of the above criteria are met, then development of a study protocol using a cross-sectional, cohort, case-control, or some other study design may be accomplished. Consideration should be given to the advantages, disadvantages, and costs of each of these methods (Bender, et al., 1988). This will be a major undertaking. Consultation with local medical authorities, and experts in the fields of cancer biology, industrial hygiene, toxicology, occupational medicine, etc., will be needed. The staff of AFOEHL/EHO is available to help in this area.

H. **Report the results.**

1. The results of the initial investigation will need to be reported on several levels. Commanders, medical authorities, and unions should receive a written report as well as a briefing. The study population should also be informed of the results. A public meeting, attended by local commanders and medical authorities may be useful, where the results of the investigation can be discussed in clear and understandable language (Schulte, et al., 1987).

2. The feasibility study may indicate that no further actions are necessary. If so, a carefully presented explanation of the scientific reasons for concluding the study may be sufficient (Bender, et al., 1988).

**IV. Beyond the report.**

1. The ultimate purpose of cancer cluster investigations is to identify and control the cause (Schulte, et al., 1987). In other words, if the mess still exists, clean it up (Rothman, 1990).

2. An additional purpose of studying cancer clusters is to allay public fears. A well-researched, well-documented investigation, the results of which are presented in clear and understandable language, should accomplish this goal.

3. If additional studies are required, complete case ascertainment and accurate definition of the population at risk are the cornerstones upon which a successful investigation will be built (Schulte, et al., 1987).

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## APPENDIX A

## ESTIMATED NEW CANCER CASES PER THOUSAND POPULATION

## BY SEX FOR ALL SITES - US 1990

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**Estimated New Cancer Cases per Thousand Population by Sex for All Sites - US 1990[a]**

| Site | Total | Male | Female |
|---|---|---|---|
| Buccal Cavity & Pharynx | 0.12 | 0.08 | 0.04 |
| Lip | 0.01 | 0.01 | 0.002 |
| Tongue | 0.02 | 0.02 | 0.01 |
| Mouth | 0.05 | 0.03 | 0.02 |
| Pharynx | 0.04 | 0.03 | 0.01 |
| Digestive Organs | 0.94 | 0.48 | 0.46 |
| Esophagus | 0.04 | 0.03 | 0.01 |
| Stomach | 0.09 | 0.06 | 0.04 |
| Small Intestine | 0.01 | 0.01 | 0.01 |
| Large Intestine | 0.44 | 0.21 | 0.23 |
| Rectum | 0.18 | 0.10 | 0.08 |
| Liver & Biliary Tree | 0.06 | 0.03 | 0.03 |
| Pancreas | 0.11 | 0.05 | 0.06 |
| Other Digestive | 0.01 | 0.005 | 0.005 |
| Respiratory System | 0.70 | 0.46 | 0.23 |
| Larynx | 0.05 | 0.04 | 0.01 |
| Lung | 0.63 | 0.41 | 0.22 |
| Other Respiratory | 0.02 | 0.01 | 0.01 |
| Bone | 0.01 | 0.005 | 0.005 |
| Connective Tissue | 0.02 | 0.01 | 0.01 |
| Skin | 0.11 | 0.06 | 0.05 |
| Breast | 0.60 | 0.004 | 0.60 |
| Genital Organs | 0.74 | 0.45 | 0.29 |
| Cervix | 0.05 | | 0.05 |
| Uterus | 0.13 | | 0.13 |
| Ovary | 0.08 | | 0.08 |
| Other Female | 0.02 | | 0.02 |
| Prostate | 0.42 | 0.42 | |
| Testis | 0.02 | 0.02 | |
| Other Male | 0.005 | 0.005 | |
| Urinary Organs | 0.29 | 0.20 | 0.09 |
| Bladder | 0.20 | 0.14 | 0.05 |
| Kidney & Other | 0.10 | 0.06 | 0.04 |
| Eye | 0.007 | 0.004 | 0.003 |
| Brain & CNS | 0.06 | 0.03 | 0.03 |
| Endocrine Glands | 0.05 | 0.02 | 0.04 |
| Thyroid | 0.05 | 0.01 | 0.04 |
| Other | 0.006 | 0.003 | 0.003 |

| | | | |
|---|---|---|---|
| Leukemias | 0.11 | 0.06 | 0.05 |
| Lymphocytic | 0.05 | 0.03 | 0.02 |
| Granulocytic | 0.05 | 0.03 | 0.02 |
| Other | 0.02 | 0.01 | 0.01 |
| Other Blood or Lymph | 0.22 | 0.12 | 0.10 |
| Hodgkin's Disease | 0.03 | 0.02 | 0.01 |
| Non-Hodgkin's Lymphoma | 0.14 | 0.07 | 0.07 |
| Multiple Myeloma | 0.05 | 0.02 | 0.03 |
| All Other Unspecified | 0.16 | 0.09 | 0.07 |
| All Sites | 4.16 | 2.08 | 2.08 |

[a]Adapted from Silverberg, BS, et al (1990).

# APPENDIX B

## CARCINOGENS WITH OCCUPATIONAL EXPOSURES LISTED BY THE INTERNATIONAL AGENCY FOR RESEARCH IN CANCER

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**Carcinogens With Occupational Exposures Listed by the International Agency for Research in Cancer[a]**

| Group/Substance | Primary Site |
|---|---|
| **Group 1[b]** | |
| Auramine manufacture | Bladder |
| Boot/shoe manufacture/repair | Nasal cavity, bladder |
| Furniture manufacture | Nasal cavity |
| Isopropyl alcohol manufacture (strong-acid process) | Sinuses, nasal cavity, larynx? |
| Nickel refining | Lung, nasal cavity |
| Rubber industry | Bladder, leukemia, stomach, lung, colon, prostate, lymphoma, brain, thyroid, pancreas, esophagus? |
| Underground hematite mining (with radon exposure) | Lung |
| 4-Aminobiphenyl | Bladder |
| Arsenic and related compounds | Skin, Lung |
| Asbestos | Lung, mesothelioma of pleura and peritoneum, stomach?, larynx, colon, rectum, esophagus |
| Benzene | Leukemia |
| Benzidine | Bladder |
| Bis(chloromethy)ether (BCME) technical grade chloro-methyl methyl ether (CMME) | Lung (oat cell) |
| Chromium | Lung |
| Mustard gas | Lung |
| 2-Napthylamine | Bladder |
| Soots, tars, and oils | Skin, lung, bladder, stomach |
| Vinyl chloride | Angiosarcomas of liver, brain, lung, leukemia?, lymphoma? |
| **Group 2A[c]** | |
| Acrylonitrile | Lung, colon, prostate |
| Benzo[a]pyrene | Skin, lung |
| Beryllium and related compounds | Lung |
| Diethyl sulphate | Larynx |
| Dimethyl sulphate | Bronchus |
| Magenta manufacture | Bladder |
| Nickel and related compounds | Nasal cavity, lung, larynx? |
| Ortho-toluidine | Bladder? |

**Group 2B[d]**

| | |
|---|---|
| Amitrole | ? |
| Auramine (technical grade) | Bladder |
| Benzidine-based dyes | Bladder |
| Benzotrichloride | Lung? |
| Cadmium and related compounds | Prostate, lung |
| Chloroform | Bladder, brain, kidney, lymphoma? |
| Chlorophenols | Soft tissue sarcoma, lymphoma |
| DDT | Soft tissue, lymphoma? |
| 3,3'-dichlorobenzidine | Bladder? |
| 3,3'-dimethoxybenzidine (ortho-Dianisidine) | Bladder? |
| Dimethylcarbamoyl chloride | ? |
| 1,4-Dioxane | ? |
| Epichlorohydryn | Lung? |
| Ethylene Dibromide | Leukemia? |
| Ethylene Oxide | Leukemia, stomach? |
| Ethylene Thiourea | Thyroid? |
| Formaldehyde (gas) | Skin?, Prostate?, GI? |
| Hydrazine | Choroid, melanoma? |
| Phenoxyacetic acid herbicides | Soft tissue, lymphoma |
| Polychlorinated biphenyls | Skin, ? |
| Tetrachlorodibenzo-parap-Dioxin (TCDD) | Soft tissue, liver, lymphoma |
| 2,4,6-Trichlorophenol | Soft tissue?, lymphoma? |

---

[a](Swanson, 1988)

[b]Group 1 -- Chemicals, groups of chemicals, industrial processes, or occupational exposures known to be carcinogenic to humans based upon epidemiologic evidence.

[c]Group 2A -- Chemicals, groups of chemicals, industrial processes, or occupational exposures thought to be carcinogenic to humans based upon limited evidence from human studies and sufficient evidence from animal studies.

[d]Group 2B -- Chemicals, groups of chemicals, industrial processes, or occupational exposures thought to be carcinogenic to humans based upon inadequate human evidence and sufficient evidence from animal studies.

## APPENDIX C

## CANCER TYPES AND RELATED OCCUPATIONS OR CARCINOGENS

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**Cancer Types and Related Occupations or Carcinogens**

| | |
|---|---|
| Bladder, urinary | Auramines (dyes)<br>4-aminobiphenyl<br>Benzidine and benzidine based dyes<br>Boot and shoe manufacturing<br>3,3'-Dichlorobenzidine?<br>3,3'-Dimethoxybenzidine<br>Magenta manufacturing (dyes)<br>Rubber industry<br>Soots, tars and oils |
| Brain | Acrylonitrile<br>Chemists<br>Chloroform<br>Oil refinery workers<br>Petrochemical workers<br>Rubber industry<br>Vinyl chloride |
| Colon | Acrylonitrile<br>Asbestos<br>Cutting oils<br>Formaldehyde?<br>Rubber industry<br>Sedentary jobs<br>Woodworking |
| Esophagus | Asbestos<br>Oil refinery workers<br>Petrochemical workers<br>Rubber industry |
| Hodgkin's Disease | Woodworkers |
| Kidney | Chloroform<br>Dinitrotoluenes?<br>Dioxane?<br>Monohalomethanes?<br>4-nitroso-dimethylamine? |
| Larynx | Asbestos<br>Diethyl sulphate<br>Isopropyl alcohol manufacturing<br>Nickel-inorganic compounds? |
| Leukemia | Acrylonitrile<br>Benzene<br>1,3-Butadiene<br>Carbon black<br>Ethylene dibromide?<br>Ethylene oxide<br>Oil refinery workers |

| | |
|---|---|
| Leukemia, cont. | PCB? |
| | Petrochemical workers |
| | Rubber industry |
| | Vinyl chloride |
| Liver | Aldrin/dieldrin? |
| | Carbon tetrachloride |
| | Chloroform |
| | Chrysene? |
| | DDT? |
| | Di-2-Ethylhexyl phthalate? |
| | Dinitrotoluenes? |
| | Dioxane? |
| | Ethyleneimene? |
| | Ethylene oxide? |
| | Hexachloroethane? |
| | Hydrazines? |
| | 4,4'-methylenebis(2-chloroaniline)? |
| | Methylene chloride? |
| | 4-nitroso-dimethylamine? |
| | 2-nitropropane? |
| | beta-propriolactone? |
| | TCDD(Dioxine) |
| | Vinyl chloride |
| Lung | Acrylonitrile |
| | Aldrin/dieldrin |
| | Arsenic |
| | Asbestos |
| | Benzo[a]pyrene |
| | Benzotrichloride |
| | Beryllium |
| | Cadmium |
| | Chloroprene |
| | Chromium |
| | Coal tar products |
| | DDT? |
| | Dimethyl sulphate |
| | Dioxane? |
| | Epichlorohydryn |
| | Ethyleneimine? |
| | Foundry workers |
| | Hydrazines |
| | Lead |
| | Metal miners |
| | Methylene chloride? |
| | 4,4'-methylenebis(2-chloroaniline) |
| | Methyl chloromethyl ether |
| | Monohalomethanes? |
| | Mustard gas |
| | Nickel-inorganic compounds |
| | Nickel carbonyl |
| | N-nitroso-dimethylamine? |
| | Printers |
| | Rubber industry |

| | |
|---|---|
| Lung, cont. | Soots, tars and oils<br>Underground hematite mining<br>Vinyl chloride |
| Lymphomas | Arsenic<br>Carbon black<br>Chemists<br>Chloroform?<br>Chlorophenols<br>DDT?<br>Phenoxyacetic acid herbicides<br>Rubber industry<br>2,4,6-Trichlorophenol<br>TCDD<br>Vinyl chloride? |
| Melanoma, choroid | Hydrazines? |
| Mesothelioma | Acrylonitrile?<br>Asbestos<br>Ethylene oxide |
| Multiple myeloma | Oil refinery workers<br>Petrochemical workers |
| Nasal cavity | Boot and shoe manufacturing<br>Dioxane?<br>Furniture manufacturing<br>Isopropyl alcohol manufacturing<br>4-Nitroso-dimethylamine?<br>Nickel, inorganic compounds<br>Nickel carbonyl<br>Textile workers |
| Oral Cavity | Printers |
| Pancreas | Chemists<br>Rubber Industry |
| Pituitary Gland | PCB? |
| Prostate | Acrylonitrile<br>Cadmium<br>Formaldehyde?<br>Rubber industry |
| Salivary glands | Methylene chloride? |
| Sinuses | Isopropyl alcohol manufacturing<br>Textile workers |
| Skin (non-melanoma) | Arsenic<br>Benzo[a]pyrene<br>Chrysene?<br>Coal hydrogenation |

| | |
|---|---|
| Skin, cont. | Coal tar products |
| | Cutting oils |
| | DDT? |
| | Dinitrotoluenes |
| | Formaldehyde? |
| | Mineral oils |
| | Nickel, inorganic compounds |
| | PCBs? |
| | Rubber industry |
| | Soots, tars and oils |
| | X-irradiation |
| Soft tissue sarcomas | Chlorophenols |
| | DDT |
| | Phenoxyacetic acid herbicides |
| | TCDD (dioxin) |
| | 2,4,6-Trichlorophenol |
| Stomach | Acrylonitrile |
| | Asbestos? |
| | Cutting oils |
| | Ethylene oxide? |
| | beta-propriolactone? |
| | Monohalomethanes? |
| | Oil refinery workers |
| | Petrochemical workers |
| | Rubber industry |
| | Soots, tars and oils |
| Thyroid | Aldrin/dieldrin? |
| | Ethylene oxide? |
| | Ethylene thiourea? |
| | Rubber industry |
| Unknown site | Amitrole? |
| | Dimethylcarbonyl chloride? |
| | 1,4-Dioxane? |
| | Ethylene dichloride |
| | Formaldehyde? |

---

?: Evidence only from experimental studies: PCB: polychlorinated biphenyls.

## APPENDIX D

## SAMPLE DESIRE TO PRINT TOTAL PERSONNEL BY SEX AND RACE, SEX AND AGE FOR EACH SHOP ON BASE.

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**SAMPLE DESIRE TO PRINT TOTAL PERSONNEL BY SEX AND RACE, SEX AND AGE FOR EACH SHOP ON BASE.**

** NOTE ** THIS DESIRE WILL HAVE TO BE ENTERED EXACTLY AS WRITTEN HERE TO FUNCTION SUCCESSFULLY, EXCEPT THE SELECT SENTENCE WILL HAVE TO BE CHANGED FOR YOUR BASE.

```
DESIRE.ID ENVIR-EPID-MATRIX RK FOR CAPT GRAYSON, OEHL/EHO, 4-
2063.PERS RECD #A. DF ETH TO BE IF PAC = "N" THEN "BLACK" ELSE IF
PAC = "C" THEN "WHITE" ELSE "NON-WHITE".DF YOB TO BE PAG<2X4#>.
DF AGE TO BE IF YOB WITHIN 66 THRU 71 THEN "19 - 24" ELSE IF YOB
WITHIN 60 THRU 65 THEN "25 - 30" ELSE IF YOB WITHIN 55 THRU 59
THEN "31 - 35" ELSE IF YOB WITHIN 50 THRU 54 THEN "36 - 40" ELSE
IF YOB WITHIN 45 THRU 49 THEN "41 - 45" ELSE ">45". SL IF BDA =
"CNBC" AND KAA NEQ 10 AND AAF NEQ "Q". ST BCA AAJ<3X4#> PAD. OT.
ADD 1 TO REG-01 IF AGE = "19 - 24". ADD 1 TO REG-02 IF AGE = "25
- 30". ADD 1 TO REG-03 IF AGE = "31 - 35". ADD 1 TO REG-04 IF AGE
= "36 - 40". ADD 1 TO REG-05 IF AGE = "41 - 45". ADD 1 TO REG-06
IF AGE = ">45". ADD 1 TO REG-07.HD PAGE 30 "ENVIRONMENTAL HEALTH
MATRIX";; 5 "UNIT" 10 TRLT BCA(2:72);; 1 "OSC" 10 "SEX" 15 "19-
24" 25 "25-30" 35 "31-35" 45 "36-40" 55 "41-45" 65 ">45" 75
"TOTAL";. OCI PAD ADD REG-0X TO REG-1X WRITE 10 TRLT PAD 11 REG-
01 21 REG-02 31 REG-03 41 REG-04 51 REG-05 61 REG-06 71 REG-07
ZERO REG-0X SPACE 1.OCI AAJ<3X4#> ADD REG-1X TO REG-2X WRITE 1
AAJ<3X4#> 6 "TOTAL" 11 REG-11 21 REG-12 31 REG-13 41 REG-14 51
REG-15 61 REG-16 71 REG-17 ZERO REG-1X SPACE 2.OCI BCA WRITE 1
"UNIT TOTAL" 12 REG-21 22 REG-22 32 REG-23 42 REG-24 52 REG-25 62
REG-26 72 REG-27 ZERO REG-2X EJECT. ST BCA AAJ<3X4#> PAD.OT.AD 1
TO REG-01 IF ETH = "BLACK".AD 1 TO REG-02 IF ETH = "WHITE".AD 1
TO REG-03 IF ETH = "NON-WHITE".AD 1 TO REG-04.HD PAGE 30
"ENVIRONMENTAL HEALTH MATRIX"; 5 "UNIT:" 10 TRLT BCA(2:72);; 1
"OSC" 10 "SEX" 15 "BLACK" 25 "WHITE" 35 "NON-WHITE" 45
"TOTAL";.OCI PAD ADD REG-0X TO REG-1X WRITE 10 TRLT PAD 11 REG-01
21 REG-02 33 REG-03 41 REG-04 ZERO REG-0X SPACE 1.

OCI AAJ<3X4#> ADD REG-1X TO REG-2X WRITE 1 AAJ<3X4#> 6 "TOTAL" 11
REG-11 21 REG-12 33 REG-13 41 REG-14
ZERO REG-1X SPACE 2.OCI BCA WRITE 1 "UNIT TOTAL" 12 REG-21 22
REG-22 33 REG-23 41 REG-24 ZERO REG-2X EJECT.ST BCA
AAJ<3X4#>.OT.ADD 1 TO REG-01 IF PAD = "M".ADD 1 TO REG-02 IF PAD
= "F".ADD 1 TO REG-03. HD PAGE 30 "ENVIRONMENTAL HEALTH MATRIX";;
5 "UNIT:" 10 TRLT BCA(2:72); 1 "OSC" 10 "MALE" 20 "FEMALE" 30
"TOTAL";.OCI AAJ<3X4#> ADD REG-0X TO REG-1X WRITE 1 AAJ<3X4#> 7
REG-01 17 REG-02 27 REG-03 ZERO REG-0X SPACE 1.OCI BCA ADD REG-1X
TO REG-2X WRITE 1 "UNIT TOTAL" 7 REG-11 17 REG-12 27 REG-13 ZERO
REG-1X EJECT.OCI FINAL WRITE 1 "BASE TOTAL" 7 REG-21 17 REG-22 27
REG-23 ZERO REG-2X SPACE 2.
```

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## Distribution List Cont'd

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